Benefit-Cost Analysis in Animal Disease Control[1/]

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Introduction

The intent of this discussion is to focus on some concepts which are basic to utilizing benefit-cost analysis. It is not intended to be a summary of benefit-cost analysis. Rather, in the limited time we have together, only the tip of the iceberg can be presented. My purpose is really to wet your appetite for benefit-cost analysis. Hopefully, you will learn more of the concept and/or feel more need to team up with economists in future research activities.

Topics to be discussed in this paper are (a) historical perspective on benefit-cost analysis and (b) basic issues in assessing costs and benefits. An important topic omitted from the discussion is (c) measurement techniques. A number of tools are available from statistics, operations research, and systems science to assist the analyst in measurement. However, it hardly seems appropriate to spend our scarce time on measurement techniques at the expense of more fundamental ideas.

Historical Perspective

The goal of benefit-cost analysis and economics in general is to provide the decision maker with information to assist him in making a choice. The analyst uses the implicit assumption that the decision maker is interested in improving societal welfare. That is, the analyst is systematically searching an array of alternative solutions and identifying the benefits as well as the

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costs of each alternative. The basic notion is that the decision maker wants to maximize net benefits to society. That is, the decision maker wants to select that alternative with the greatest net benefits as long as these net benefits are positive.

The idea of maximizing net benefits is hardly new. I suppose Eve was thinking of maximizing net benefits when she ate the apple. Her only problem was that she estimated the costs incorrectly.

A nineteenth century Frenchman, Jules Dupuit, offered the intellectual foundation for much of today's analysis. He recognized the existence of something called "consumer surplus" which is discussed later. The problem which Dupuit analyzed was public expenditures and financing of bridges and roads. He proposed that the benefits of bridges and roads are not the actual receipts generated by tolls, but benefits are the public's willingness to pay.

The parallel of Mr. Dupuit's problem of valuing bridges to veterinary medicine's problem of valuing disease control is obvious. You know that control of disease is an important proposition. You know disease control benefits are more than the price which farmers pay for preventive health care. Mr. Dupuit provided the foundation for theories which support your beliefs about the benefits of your programs.

The first systematic application of benefit-cost analysis to public decisions came in the 1930's. The Flood Control Act of 1936 set forth the standard that water project benefits had to be greater than costs. A number of agencies including the Army Corps of Engineers, the Department of Interior and the U.S. Department of Agriculture began developing methodology for measuring costs and benefits.

In the past four decades benefit-cost analysis has expanded dramatically. It reached its zenith in the 1960's in an attempt to evaluate expanding federal programs. In the areas of defense, natural resource policy, and domestic programs, relevant policy alternatives were examined by estimating to the extent possible, the expected economic costs and benefits.

Assessing benefits and costs is done in both the public and private sector. In the private sector it is referred to as "investment analysis", and the objective is quantify the net private gain to the business of a particular course. In the public sector, the objective is to quantify net societal gain of a particular course. Measurement concepts used for benefit-cost analysis are quite different from those used in investment analysis.

Basic Issues In Measuring Benefits And Costs

An example should help point out the capabilities of benefit-cost analysis. Assume that a program to reduce swine tuberculosis is to be evaluated. (This example is an actual analysis done by the Animal and Plant Health Inspection Service of U.S.D.A.) After considerable effort, the following streams of benefits and costs are derived.

Table 1. Swine tuberculosis control program, annual benefits and costs

Year	Actual Benefits ($ millions)	Actual Costs ($ millions)
1	.056	.58
2	.349	1.41
3	.867	1.66
4	1.406	1.66
5	1.891	1.66
6	2.317	1.66
7	2.679	1.66
8	2.952	1.66
9	3.111	1.66
10	3.099	1.66
11	2.925	1.66
12	2.729	1.66
Sum	24.381	19.59

We have skipped over many arduous steps in deriving these costs and benefits. There are many important judgements to be made by professionals about future benefits of a program. Also, there might be a great deal of statistical finesse used to arrive at the costs and benefits. But we gloss over these steps to bring out some important points.

Time Value of Money

First, the time value of money must be considered in adding benefits and costs. Using the "Sum" in Table 1 is not the correct estimate of benefits and costs. Consider spending $1.66 million in year 3. The question is, "What is $1.66 million in three years worth today?" Today, we could invest something less than $1.66 million and have it grow to $1.66 million with the help of compound interest.

We use the "present value" concept to estimate today's value of some future cost and benefit. The present value of $1 at the end of some selected years is shown in Table 2.

Table 2. Present value of $1 at the end of n years at i rate of interest

n	i		
	.06	.08	.10
1	.94	.93	.91
2	.89	.86	.83
3	.84	.79	.75
.	.	.	.
.	.	.	.
10	.56	.46	.39
.	.	.	.
.	.	.	.
20	.31	.21	.15

What is the present value of $1.66 million in the third year? Well, it depends on the interest rate or discount rate. We know that society has many other ways to spend scarce capital than on swine tuberculosis control. Possibly it means sacrificing an 8 or even 10 percent annual return. Thus, the correct measure of the programs future benefits and cost would be to convert future benefits and costs into present value measurements (Table 3).

Table 3. Swine tuberculosis control program, annual costs and benefits discounted at 8 percent

Year (1)	Present Value Of $1 (2)	Benefits Actual (3)	Benefits Discounted (4)=(2)x(3)	Costs Actual (5)	Costs Discounted (6)=(2)x(6)
		-------------------$ millions	----------------------		
1	.93	.06	.05	.58	.54
2	.86	.35	.30	1.41	1.21
3	.79	.87	.69	1.66	1.32
4	.74	1.41	1.03	1.66	1.22
5	.68	1.89	1.29	1.66	1.13
6	.63	2.32	1.46	1.66	1.05
7	.58	2.68	1.56	1.66	.97
8	.54	2.95	1.59	1.66	.90
9	.50	3.11	1.56	1.66	.83
10	.46	3.10	1.44	1.66	.77
11	.43	2.93	1.25	1.66	.71
12	.40	2.73	1.08	1.66	.66
Sum			13.30		11.29

The program's net benefits total $2.01 million (13.30 - 11.29) if a discount rate of 8 percent is applied to the future costs and benefits. The program looks favorable. Of course similar analyses would have to be done for other programs to determine if this is the "best" program or merely a "good one".

Choice Criteria

The previous example illustrated one criterion to evaluate a program--<u>net present value</u>. A second criterion might be the <u>benefit-cost ratio</u> (B/C) where

$$B/C = \frac{\text{present value of economic benefits}}{\text{present value of economic costs}}$$

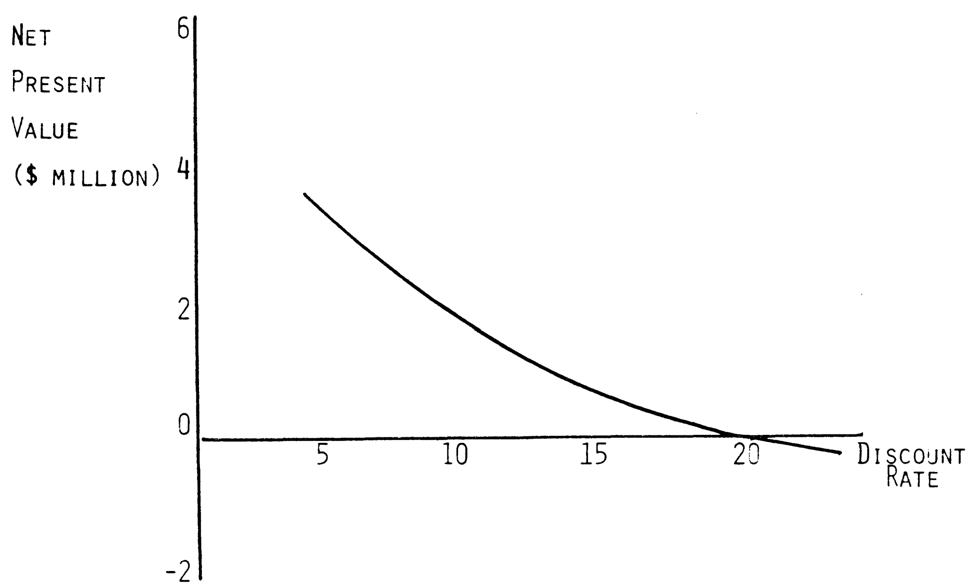
From our example in Table 3,

B/C = 13.30/11.29 = 1.18

If the ratio is greater than one, project expenditures are judged to be worthwhile. If the ratio is equal to one, the project adds nothing to the economy. If the ratio is less than one, it detracts from economic well being.

A third criteria often presented is the <u>internal rate of return</u>. The internal rate of return is that discount rate where the present value of future benefits equals the present value of future costs. That is, the net present value of all future income flows is exactly zero. In Figure 1, the net present value varies as the discount rate varies. At some discount rate (19.5 percent), the net present value is zero. If society is to receive positive benefits from the program, the internal rate of return should exceed society's opportunity cost of capital.

FIGURE 1. NET PRESENT VALUE OF SWINE TUBERCULOSIS CONTROL PROGRAM, BY DISCOUNT RATE



The immediate question raised by the net present value criterion and the internal rate of return criterion is, "What interest rate should be used?" If we compute the net present value, some interest rate is needed to discount future income flows. After computing the internal rate of return, some standard is needed to judge the adequacy internal rate of return.

Society has many alternatives other than disease control for its scarce resources. Funds could be invested in other long term projects, or they could be consumed today. They could be either in the private or public sector. The most appropriate interest rate is the rate of return earned on capital in the private sector.

There are several reasons for arguing that the discount rate to be used on public investments (like disease control) may be lower than the rate of return on capital in the private sector. Some have argued that private investments are too myopic in nature. They tend to discount the welfare of future generations too heavily, as witnessed by man's gluttonous consumption of nonrenewable energy stocks. Another argument for having the discount rate on public projects below the private sector interest rate is that risk is less in public projects. That is, the interest rate in the private sector includes some risk of repayment component. Supposedly this risk of repayment is substantially lessened in the public sector. However, most analyses use the rate of return in the private sector since it most nearly reflects society's opportunity cost of capital.

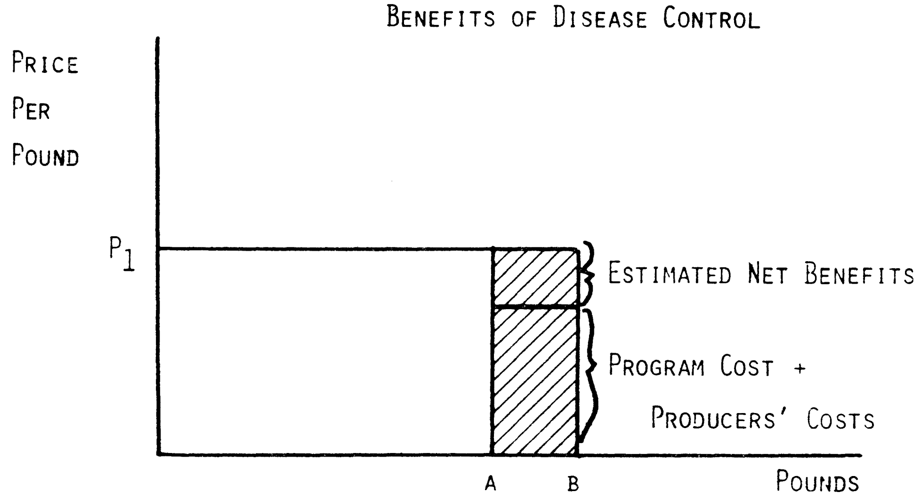
To summarize the basic considerations in measurement, all costs and benefits over the life of the proposed project need to be considered. Three criteria are available to determine the adequacy of the proposed project--net present value, benefit cost ratio and internal rate of return.

Any of these measures are satisfactory criteria of choice. There are more arguments in favor of using the net present value or benefit cost ratio than the internal rate of return. However, these are relatively complex technical arguments that are not discussed here. Another often used choice criteria is cost effectiveness. Here benefits are considered to be similar for a number of alternative programs. Thus, benefits are ignored, and the costs of the alternative programs are compared. That program with the lowest cost is recognized as the "best" alternative. In many cases, disease control programs might be evaluated by cost effectiveness analysis.

Consumer Surplus

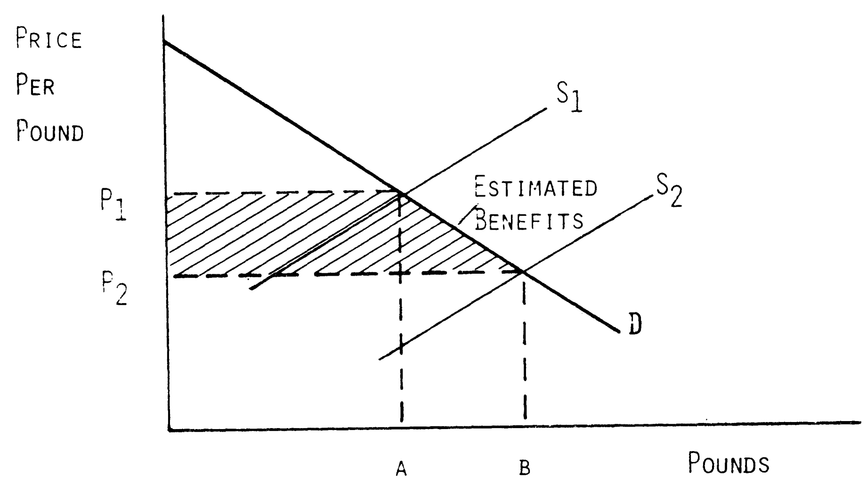
The most crucial concept in measuring benefits is consumer surplus. Consumer surplus is the amount which consumers are "willing to pay" rather than the amount they actually pay. Consider the program to control swine tuberculosis. Gross benefits might be calculated by simply multiplying current market price times the quantity of swine saved or $P_1 \cdot (A - B)$ in Figure 2. Then net benefits might be calculated by subtracting producer's costs and the program cost. This method is conceptually incorrect.

FIGURE 2. INCORRECT METHOD OF VALUING BENEFITS OF DISEASE CONTROL



The demand curve for swine is quite inelastic rather than perfectly elastic as depicted in Figure 2. A typical demand curve is illustrated in Figure 3 as line D. As swine are saved by a disease control program, supply increases from S_1 to S_2, and quantity supplied to consumers increases from A to B. It should be noted that in the long run P_2 just covers producers' total costs. It includes <u>no</u> excess profits. Disease control does not help producers earn greater profits in the long run!

FIGURE 3. CORRECT METHOD OF VALUING BENEFITS



The benefits of a disease control program must consider explicitly the slope of demand in computing the net benefits. With more swine produced as a result of the disease control program, prices would drop and benefit consumers.

Elasticity of demand is the economist's jargon for the slope of the demand curve. Elasticity of demand is defined as:

$$\frac{\text{percent change in quantity}}{\text{percent change in price}}$$

For swine, the elasticity of demand is about -.50 at the farm level. Thus, every 1 percent decrease in farm level price brings forth about a .5 percent increase in quantity consumed. Consider the impact of a disease control program to increase the quantity of swine. A 1 percent increase in the quantity of swine produces about a 2 percent decline in swine prices.

Thus, a disease control program benefits consumers by the shaded region in Figure 3. Prior to the program, they pay relatively high prices. After the disease control program, more swine in available at a lower price. Net benefits would equal consumer benefits (shaded area in Figure 3) minus program costs.

Does the producer benefit? In the short run, he might be able to capture some of this consumer surplus. But in the long run, competitive forces in the swine industry assure that any increases in efficiency are translated into lower swine prices and no profits accrue to him. Rather consumers reap the benefits of the program.

Animal disease control <u>is</u> <u>not</u> a program to benefit farmers. Rather it is a consumer assistance program. Too often we fail to understand the real impact of our actions. Our intent is probably to help the animal industry by lessening disease losses. However, the nature of the competitive animal industry assures that our cost reducing innovations are quickly translated into lower consumer prices.

External Effects

The most often committed error in the analysis of animal disease control is to omit external effects or "spillover effects". External effects are those costs or benefits which are not included in the direct economic impacts of a decision but have incidental or unintentional effects. The analyst investigating disease control needs to be cognizant of any possible external effects. Animal and human health have abundant cases of spillover effects. For example, consider the control of contagious diseases. The individual producer certainly recognizes costs of a disease in his herd. However, he does not recognize the costs which he might impose on neighboring herds if the disease spreads to other herds. The treatment which he uses for his own herd may be quite different than the treatment to prevent exposure of neighboring herds. Thus, the necessity of public agencies to monitor animal health and to take action which is in the best interest of society.

Public goods are the extreme case of goods with external effects. Instead of having some effects which spillover, all the effects spillover to the public and can not be captured by a firm. When society provides national defense or public health services, it is recognized that government must supply these services if they are to exist. No producer would provide them since he could not capture the benefits. Rather the benefits of defense and health spillover to the entire population. Any potential buyer would be unwilling to pay anything for defense or public health. Instead he would say, "If I pay, someone else will reap the benefits. If I refuse to pay, someone else may pay and indirectly benefit me. Thus I'll wait for my neighbors to supply the goods." Only through collective action can the availability of a public good be assured.

Most goods have some spillover effects, but few are so severe to be categorized as public goods. The important point to recognize is that market price may be an erroneous indicator of value. For example, the chemical manufacturer flushing residuals into the water supply imposes costs on others. The price of his product does not adequately reflect society's costs. Similarly, the market price of disease prevention is not an adequate measure of its value to society. The buyer of health services does not internalize the impacts he imposes on others in the community. A good or service with external effects is always misjudged by market forces.

Income Distribution Impacts

In the case of spillover effects or public goods, market failure is explicitly considered. That is, the counting of society's benefits and costs may be quite different than the counting of a firm's benefits and costs. When counting society's benefits and costs we are certainly interested in efficiency. Spillover effects or public goods provides a basis for collective action to improve efficiency.

Our analysis also needs to consider the equity impacts. "Whose ox is gored?" is the question that needs to be included in our analysis. For example, much of the credit for expanded herd sizes and reduced numbers of producers can be taken by disease control. Efficiency may be improved, but is income distribution improved? Or is it a case of the large producer now being able to crowd out the small producer? There is no way to enter the income distribution impacts in the analysis. At least it needs to be considered as another piece of information which should be supplied to the decision maker.

Summary

Benefit-cost analysis is a useful tool in analyzing the economic impacts of disease control. The purpose is to assist the decision maker in choosing between alternatives. However, seldom is it able to quantify all the impacts of a decision. Impacts such as income distribution effects and spillover effects may be unquantifiable.

Basic considerations in valuing animal disease control programs include (a) the time value of money or discounting, (b) the criteria for choosing between alternatives, (c) consumer surplus, (d) external effects, (e) public goods, and (f) income distribution impacts. It is my judgement that most of the analysis of public disease control programs are incomplete. If economic analysis of alternative programs is done, many of the benefit-cost concepts are neglected.

How do we improve economic analysis in disease control programs? More team work is needed. The resource economist and the veterinarian or epidemiologist should be more willing to link their disciplines. This link has been missing in the past as evidenced by the lack of benefit-cost analyses in the literature, and the public has borne the cost.

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